



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation

September 11, 1998

Volunteer Fire Fighter Dies of a Heart Attack after Conducting Firefighting Activities at a Single Family Log Cabin Dwelling - Virginia

SUMMARY

On December 7, 1997, a 52-year old male volunteer fire fighter succumbed to a heart attack 19 hours after fighting a fire in a 200 year-old renovated two-story log cabin. The fire fighting effort was made emotionally difficult by the fact that the 27-year-old female occupant of the dwelling burned to death in the fire, and physically difficult because the heavy timber construction of the log cabin made overhaul efforts laborious. After conducting fire fighting activities for over 4 hours, the fire fighter returned to quarters from the fire at 0445 hours on December 6. Later that day, he assisted with fund-raising activities, but left the fire station early because he was not feeling well. His wife found him in cardiac arrest when she arrived at home at approximately 2320 hours, December 6. He was pronounced dead at 0030 hours, December 7. No autopsy was performed. The cause of death listed on the death certificate was coronary artery disease as a consequence of fatigue/exhaustion.

It is possible that the fire fighting activities conducted by this fire fighter 19 hours prior to his heart attack contributed to or triggered the fatal heart attack. A number of complicating factors, including the lack of an autopsy, make it difficult to assess the extent to which these activities increased his risk of a work-related incident. There were no periodic municipality-sponsored medical evaluations or cardiovascular/respiratory fitness programs for volunteer fire fighters in this department.

A three-pronged strategy for reducing the risk of heart attacks among fire fighters has been proposed by other agencies. This strategy consists of: 1)

minimizing physical stress on fire fighters; 2) screening to identify and subsequently rehabilitate high risk individuals; and 3) encouraging increased individual physical capacity. Steps that could be taken to accomplish these ends include:

- ***Implementing an overall health and safety program such as the one recommended in National Fire Protection Association (NFPA) 1500, Standard on Fire Department Occupational Safety and Health Program.***
- ***Providing fire fighters with periodic medical examinations.***
- ***Initiating a wellness/fitness program to reduce risk factors for cardiovascular disease and improve cardiovascular capacity.***

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at:

<http://www.cdc.gov/niosh/firehome.html>

or call toll free **1-800-35-NIOSH**.

INTRODUCTION/METHODS

NIOSH was notified of this fatality on December 15, 1997. NIOSH telephoned the fire department during the week of January 5, 1998 to initiate the investigation. Jane McCammon, Senior Industrial Hygienist and Tom Hales, Senior Medical Officer from the NIOSH Fire Fighter Fatality Investigation Team traveled to Virginia on January 26, 1998 to conduct an investigation of the incident.

NIOSH personnel began the investigation by meeting with and interviewing:

- Fire department officers from both the first call and assisting fire departments
- A coworker of the deceased firefighter
- The county Fire Marshall supervising the fire scene investigation.

NIOSH also:

- Reviewed fire department and Fire Marshall investigative records including incident reports, photographs of the fire, coworker statements, dispatch records, and the death certificate
- Visited and photographed the fire scene
- Reviewed relevant medical records.

INVESTIGATIVE RESULTS

Fire Scene Response. Late in the evening of December 5, 1997, Department 1 was dispatched to assist a neighboring Department (Department 2) in fighting a structural fire as part of a mutual aid program. The fire was in a two-story renovated log cabin dwelling that was fully involved with fire when the responding Departments arrived. The resident of the dwelling had not been accounted for when the Departments arrived, so it was assumed that a victim was still inside.

Department 2 was the first to arrive at the fire, and the Chief of Department 2 assumed Incident Command. Department 1 arrived within six minutes. Ultimately, four fire departments were dispatched to this fire, responding with a total of 5 engines, 3 tankers, 1 ladder, 1 squad truck with specialized pieces of equipment, and one rescue unit (EMS). The first-due Department (Department 2) sent 16 fire fighters, Department 1 sent 13 fire fighters, and two other departments (Departments 3 and 4) sent 9 and 5 fire fighters each. Four EMTs were also dispatched from the first-due municipality.

Soon after the Departments arrived at the fire, fire fighters realized that there was no chance to rescue anyone that might still be inside the building. Because of the amount of fire and the extent of structural collapse already taking place in certain areas of the dwelling, the Departments launched an exterior attack with handheld hoselines.

Initially, the water tanker to which the deceased fire fighter was assigned was stationed at the end of the 500-foot driveway to establish water supply. After dual

supply lines were established, the Department 1 fire fighters were assigned to assist with fire extinguishment on the North side of the dwelling. The crew used a hoseline and some hand tools to mount an exterior attack and overhaul of the structure while searching for the building occupant in areas close to any openings. Investigative statements indicated that duties conducted by the deceased fire fighter at the fire scene included setting up the draft area, working with a hose line later during in the fire, and using a pike pole during the overhaul phase.

The external fire extinguishment operations continued for approximately an hour until the bulk of the fire was extinguished. Because searches of the surrounding area and other attempts to account for the occupant had not been unsuccessful, the Departments then began interior searches in parts of the building that were still standing and deemed safe to enter. The body of the building occupant was eventually located within the burned dwelling. In addition to the death of the occupant, two fire fighters were injured at the fire scene during the course of fighting this fire. One fire fighter suffered a mild burn from contact with the fire; another fire fighter suffered a moderate injury when struck by a piece of a wall.

The deceased fire fighter did not enter the building to search for the occupant. All of his activities were conducted outside the building, and thus, he was not required to use his self-contained breathing apparatus. Photos of the fire fighter taken by the Fire Marshall during these activities indicated that the deceased fire fighter was wearing full PBX turnout gear (coat and pants, boots, helmet, gloves) but was not wearing his SCBA apparatus as he fought the fire. He conducted fire fighting activities at the scene from 2347 hours on December 5 until returning to quarters at 0445 hours December 6. He had not conducted any other fire fighting activities for two or more days prior to this incident.

Witness statements indicated that the deceased fire fighter demonstrated no signs of fatigue, overexertion, or other symptoms that would have dictated a need for rehabilitation or other medical treatment during fire fighting activities. In addition, witnesses interviewed during this investigation stated that he and other fire fighters were questioned about their emotional status subsequent to the discovery of the body of the dwelling occupant. All fire fighters, including the deceased fire fighter, indicated that they were fine, and that there was no need for Critical Incident Stress Debriefing.

The following timeline related to the incident fire was abstracted from the county dispatch log. Initial arrival times for each of the four departments and entries relevant to the duration of the fire fighting effort by the deceased fire fighter were abstracted.

Time	Activity/Event Summary
<i>23:24:42</i>	Initial fire report received
<i>23:27:17</i>	Units dispatched
<i>23:37:21</i>	First-due Department 2 Fire Chief arrives at fire scene, reports well-involved structural fire
<i>23:40:28</i>	Department 2 fire fighting equipment arrives at fire scene
<i>23:43:57</i>	Department 1 fire fighting equipment (pumper) arrives at fire scene
<i>23:44</i>	Dispatch is advised of the possible entrapment of the resident in the fire
<i>23:44:34</i>	Department 1 ambulance arrives at the fire scene
<i>23:45:05</i>	Department 3 tanker arrives at the fire scene
<i>23:46:49</i>	Department 1 ladder truck to which the deceased was assigned arrives at the fire scene
<i>23:47:07</i>	Fire Marshall arrives at the fire scene
<i>23:51:38</i>	Department 4 tanker arrives at the fire scene
<i>01:51</i>	Presence of a body within the building is confirmed
<i>04:30</i>	Department 1 equipment to which the deceased was assigned left the fire scene to return to the fire station

<i>09:46:17</i>	Final dispatch of fire fighting equipment to the fire scene for handling "hot spots"
<i>11:42</i>	All units in quarters.

EMS Response to the Medical Emergency

Statements from witnesses indicated that the deceased fire fighter was at the Fire Station during the afternoon and early evening of December 6, assisting with the fund-raising sale of Christmas trees. He went home early in the evening because he was not feeling well, and mentioned that he had had a cold earlier in the week. He was last seen at approximately 2030 hours. When his spouse returned home from working the evening shift at a nursing home, she found him in the bedroom, which was highly unusual because he always waited up for her. She discovered that he was in cardiac arrest, and immediately called 911 for assistance.

The emergency call was received at 2326 hours, and an advanced life support unit was immediately dispatched. Emergency medical units arrived at the fire fighter's residence approximately 4 minutes after dispatch. The paramedics found that the spouse had initiated cardiopulmonary resuscitation, which they continued. The paramedics' initial evaluation found the fire fighter cyanotic, unconscious with unresponsive pupils, and no respirations. The fire fighter was intubated and placed on 100% oxygen. A heart monitor showed ventricular fibrillation, for which the fire fighter received two attempts at electro-cardioversion at 2337 hours. Over the ensuing 33-minute period, an intravenous (IV) line was placed and three IV injections of epinephrine were given. In addition, IV atropine and saline were administered. No blood was drawn.

Transport to the hospital emergency department was initiated at 0010 hours, with arrival at 0025 hours. The fire fighter never regained consciousness and was pronounced dead on arrival at the hospital.

MEDICAL FINDINGS

The death certificate was completed by the medical examiner on January 7, 1998. The immediate cause of death was listed as "coronary artery disease due to fatigue/exhaustion."

Medical records indicated he had risk factors for coronary artery disease. No autopsy was performed.

DESCRIPTION OF THE FIRE DEPARTMENT

This 40 member volunteer fire department (Department 1) is part of a 900-1000 countywide volunteer system. This system is comprised of 17 independent volunteer fire and rescue services. The county served by this system covers approximately 517 square miles, with a population of approximately 180,000.

The population of the 4 square mile municipality that houses Department 1 is 2,500. The first-due service area of the Department covers approximately 30 square miles. The longest response run time for the Department is twelve minutes. Responding fire fighters and equipment leave the Fire Station within two minutes of receipt of the initial dispatch or call. The Department aims for a minimum staffing of 4 people for engine or ladder truck before departure from the Fire Station, although they will go with 3 people (under a designation of "understaffed")

Approximately 2/3 of the funding for the Department is obtained through fund-raising efforts. The remaining funding is provided by city, county, and state tax bases.

The Department operates under a written Incident Management System modeled after the United States Fire Administration system. The Department uses PBX turnout gear and Scott 4.5 SCBA with 30-minute low-profile cylinders.

Some members of Department 1 are career fire fighters in other departments.

The Department responds to approximately 300 emergency calls per year, 25% of which are automobile crashes, 25% brush or other miscellaneous fires (spilled gasoline, etc.), and 50% are structural fires. The Department does not respond to calls for emergency medical services.

DESCRIPTION OF MEDICAL/PHYSICAL TRAINING/SUPPORT SERVICES PROVIDED FOR FIREFIGHTERS

Because Virginia has a Heart/Lung Bill (fire fighter heart and/or respiratory problems developed after employment are automatically assumed to be work-related), the county provides all fire fighters with an initial baseline medical evaluation to establish health status of the person prior to service with the

Department. Candidates with preexisting medical problems and/or risk factors are accepted for service with the items of concern noted in the candidate's file. No medical evaluation beyond the baseline is provided for volunteers with the Department. Hazardous Materials response teams are provided with full medical evaluations annually. Medical evaluations are provided by the County Health Department.

Career fire fighters who volunteer for this Department are medically evaluated annually for respirator clearance by their employing Department. Volunteer fire fighters are not medically evaluated for respirator clearance.

This department has a Critical Incident Stress Debriefing system in place. There was no program in place to enhance cardiovascular/respiratory fitness of fire fighters.

SERVICE HISTORY OF THE DECEASED FIRE FIGHTER

The fire fighter had been a volunteer with this department for 3 years. He was trained at the Fire Fighter 1 level and did not respond to hazardous materials incidents. His salaried position was as a senior auditor for a Federal government agency.

DISCUSSION

Data collected by the National Fire Protection Association (NFPA) indicate that forty-nine percent of on-duty fire fighter deaths occurring nationally in 1996 resulted from heart attacks.¹ NFPA data also indicate that heart attacks have always been the most common cause of on-duty fire fighter deaths since the agency began collecting data in 1978.

Firefighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and persist through the course of fire suppression activities.² Fire fighters interviewed as part of this investigation indicated that log cabin fires are difficult to fight because of the weight of the timbers and other materials that must be moved during the overhaul phase of the operations. Further, conducting these types of activities in full turnout gear carries a high energy cost. For example, one study of fire fighters climbing stairs in full equipment found that the fire fighters reached 80% of their maximum oxygen consumption and 95% of their maximal heart rate, and required at least 39 milliliters

of oxygen per kilogram of body weight per minute.³ Other studies have shown similar results.⁴ These sudden and sometimes prolonged increases in heart rate may trigger coronary artery plaque disruption, leading to artery blockage, causing a heart attack and sudden death.⁵⁻⁷ Exposure to the heat of the fire, the stress of carrying out fire fighting activities, dealing with fire-related fatalities, and chronic exposure to the many components of smoke all present an intense burden and corresponding high oxygen demand on the body and heart of a fire fighter.

It is possible that the fire fighting activities conducted by this fire fighter 19 hours prior to his fatal heart attack contributed to or triggered the fatal heart attack. However, there are a number of complicating factors that make it difficult to assess the extent to which these activities increased his risk of a work-related incident. Foremost is the lack of an autopsy. For example, the fire fighter could have experienced a mild heart attack during fire suppression activities which then led to a cardiac arrhythmia 19 hours later. But without autopsy information, the exact time of his heart attack is unknown.

Although the municipality provides volunteer fire fighters with medical programs upon acceptance in the department, they do not require these on a periodic basis for all fire fighters. This fire fighter had no municipality-sponsored medical evaluation for three years prior to his death. In addition, this department had no programs in place to enhance cardiovascular/respiratory fitness of fire fighters.

RECOMMENDATIONS

The following is a list of preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks among fire fighters. These recommendations have not been evaluated by NIOSH, but represent research presented in the literature, consensus votes of Technical Committees of the National Fire Protection Association, or labor/management groups within the fire service.

Recommendation #1: Implement an overall health and safety program such as the one recommended in of NFPA 1500, Standard on Fire Department Occupational Safety and Health Program.⁸

Discussion: NFPA 1500 provides the framework for a safety and health program for fire departments. The specified goal of the standard is to reduce the probability of occupational fatalities, illnesses, and disabilities among fire fighters. NFPA points out that the standard is meant to be appropriate for voluntary compliance tailored to

the needs of each individual department. Formal implementation of the standard, particularly the development of a written plan for compliance with NFPA 1500, should include development of fire service occupational health programs outlined both in NFPA 1500 and 1582 (discussed below).

Recommendation #2: Provide fire fighters with periodic medical examinations as required by the Occupational Safety and Health Administration (OSHA), and recommended by NFPA, and the International Association of Fire Fighters/International Association of Fire Chiefs.

Discussion: Because Virginia is a state-plan state, municipalities within Virginia are required to comply with OSHA requirements. OSHA's revised respiratory protection standard⁹ requires that employers provide medical evaluations for employees using respiratory protection. OSHA's Fire Brigade standard¹⁰ also requires that the employer assure that employees who are expected to do interior structural fire fighting are physically capable of performing such duties. Further guidance regarding the content and scheduling of periodic medical examinations for fire fighters can also be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters,¹¹ and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative.¹²

Applying the above OSHA and NFPA standards involves legal and economic implications and must be carried out in a nondiscriminatory manner. Appendix D of NFPA 1582 provides guidance for fire department administrators regarding legal considerations in applying the standard.

Economic implications go beyond the costs of administering the medical program. Department administrators, unions, and fire fighters must also deal with the personal and economic costs of the medical testing results. NFPA 1500 addresses these issues in Chapter 8-7.1 and 8-7.2. The success of medical programs may hinge on protecting the affected fire fighter. The department should provide alternate duty positions for fire fighters in rehabilitation programs, if possible. If the fire fighter is not medically qualified to return to duty after repeat testing, supportive and/or compensated alternatives for the fire fighter should be pursued by the Department.

Recommendation #3: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by implementing a wellness/fitness program for fire fighters.

Discussion: NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being. In 1997, the International Association of Fire Fighters and the International Association of Fire Chiefs joined in a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual with a video detailing elements of such a program.¹² These materials should be reviewed by the fire department to identify elements that would be feasible and effective in their situation.

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Figure. Log cabin where fire occurred.